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# COASTAL GEOMORPHOLOGY OF NEW JERSEY VOLUME I

Karl F. Nordstrom

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Center for Coastal and Environmental Studies

THE COASTAL GEOMORPHOLOGY OF  
NEW JERSEY  
VOLUME I

Management Techniques  
and Management Strategies

by

Karl F. Nordstrom  
Technical Report 77-1

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## ABSTRACT

This report presents a set of recommended guidelines for a management program designed to assess the effects of erosion of the New Jersey shoreline and evaluate techniques for addressing this erosion. This is an initial step in the development of policy statements for management of the beach resources within the state. An effort has been made to identify strategies which are compatible with the dynamics of the shoreline system and which maximize the recreational and protective values of the beach and dune areas.

The report examines the condition of the beaches and dunes in terms of future needs and available resources. Attention is largely devoted to methods for improving the potential of the beachfront for recreation and protection because these land use options are clearly the most suitable, considering the dynamics of the system.

The natural trends of development of the beaches and the migration of barrier islands is considered along with the effects of man. The report points out the importance of the dune area and the problems resulting from housing construction on the natural barrier island system. The migration of inlets due to longshore transport is also pointed out because erosional problems are particularly acute at the north end of the barrier islands. The possibility of using beach fill and sand bypass systems to improve conditions is explored as well as construction or alteration of groins, jetties, seawalls, and other static protective measures.

Budgetary constraints at Federal, State, County, and Municipal levels restrict the implementation of many measures. It is, therefore, imperative to get the most use out of the dollars for beach protection. Accordingly, areas of particular concern have been identified as well as areas which should receive special attention for development as recreation areas or for preservation. Planning strategies are suggested which recognize the dynamic nature of the barrier islands and inlets while maintaining a balance between the optimum use and the preservation of the natural environment. It is acknowledged, however, that the formulation of specific policy statements requires a more thorough examination of the economic and environmental controls operative, as well as the interests of local groups and the policies of the other governmental agencies charged with regulating land use in the coastal zone.

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FORWARD

This document is part of a two volume report prepared for the State Office of Coastal Zone Management by the Rutgers University Center for Coastal and Environmental Studies. The purpose of Volume Two is to develop a system for describing the New Jersey shoreline in terms of beach dynamics, identify and characterize problem areas, and suggest which management alternatives may be applied to relieve the problem conditions. This information is used in this volume to recommend preferred management techniques and State policies.

This volume contains the management techniques and management strategies which should be implemented by the State of New Jersey to achieve the maximum use of the vital beach resources of the state and to minimize the erosion hazard to the greatest extent possible. Although a good deal of the information presented in this report is based upon that presented in the Basis and Background volume (Volume II), this report is intended to be a free-standing document. Much of the information presented in Volume II is summarized here, and few planners will have need to refer to that document.

The report was developed in cooperation with Stewart E. Hougan and David N. Kinsey of the Office of Coastal Zone Management and Bernard J. Moore of the Office of Shore Protection, State of New Jersey, Department of Environmental Protection. The author gratefully acknowledges the assistance of the staffs of each of the shorefront communities and county offices contacted as well as the public officials and private individuals too numerous to mention here. The following individuals deserve special mention for the time they took to contribute to the report.

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## INTRODUCTION

### Overview of the Problem

Continuing erosion of the New Jersey beaches coupled with shorefront construction has resulted in the reduction of their usefulness for recreation and as a form of protection. A large part of the economy of the state is dependent upon the availability of adequate beaches, and millions of dollars are being spent for beach protection for buildings and facilities in the beachfront communities. Structural and non-structural measures, to include land use planning, are required to insure the welfare of the shorefront residents, the wildlife, insure the viability of the State's multi-million dollar resort industry, and maintain the quality of the recreational experience. In spite of most efforts, the beaches are still eroding as a result of rising sea levels and continued longshore transport.

This report is designed as an initial step in the development of a program for the management of the beach, nearshore, and dune environments. This phase of the program will then be linked to the offshore and onshore environments as part of the comprehensive coastal zone management package.

### Methodology

The methodology used in this study has been to break the shoreline down into a number of segments for detailed analysis, examine the similarities and differences among each of the compartmentalized beach segments and to then use this information to develop management techniques and strategies. The methods employed take into consideration the great variety of forms, yet allow for the development of general management guidelines which are applicable to the whole state.

The analysis of beach segments included detailed inspection of the excellent series of 1:10,000 scale aerial photographs available within the New Jersey Department of Environmental Protection, analysis of low elevation, oblique aerial photographs flown specifically for this project, and extensive field reconnaissance. Programs developed in other states in their Coastal Zone Management Programs were considered, as well as the numerous documents on the shoreline of New Jersey developed by the U.S. Army Corps of Engineers. The guidelines recommended here are designed to be compatible with the physical processes which are operative within each one of the distinct geomorphic units and the recommendations reflect the thinking of coastal geomorphologists. However, care was taken that the recommendations were guided by the principles established by the planning staff of the state Office of Coastal Zone Management.

## Guiding Principles

The document entitled Alternatives for the Coast (N.J. OCZM, 1976) presented several basic principles to guide the formulation of the alternative policies identified below. These principles establish fundamental attitudes toward coastal resources, appropriate land and water uses of coastal resources, how these resources are used, and how public decisions are made on the use of the coast and its resources.

1. The productivity of existing marine resources should be maintained or improved.
2. The shoreline should be devoted only to activities that depend upon direct water access and require a shoreline or waterfront location.
3. The valuable upland, air, land, and water resources of the natural environment of the coast should be respected and protected.
4. The design of coastal land uses should respect and reinforce the visual characteristics of diverse parts of the coast. The mix of scenic resources of the New Jersey coast should be maintained.
5. Orderly, balanced, residential, commercial, and industrial development should be accommodated in the coast, in settlement patterns that are economically efficient and respect the natural environment.
6. Activities that increase public access to the coast should be encouraged, and existing public rights of access to the coast should be protected.
7. Development of coastal resources may best take place when an appropriate geographic strip of land or water - a buffer - separates the development site from valuable surrounding resources and absorbs or mitigates the impact of the development.
8. Coastal resources and uses should be considered in terms of both their regional and site specific characteristics and impacts.

Not all of these principles are compatible with the desires of all of the State residents and a certain amount of antagonism to new State management policies may be expected. However, when problem areas are viewed in the light of natural processes, the appropriate solution becomes quite clear and the state may feel comfortable in proposing a particular strategy. For example, discouraging residential or commercial development in a high risk erosion area is clearly the most responsible policy. Optimum land use is then dependent upon the physical characteristics of the shoreline segment.

## State Involvement

Three alternative goals identifying different levels of state control over shoreline land use are proposed as a basis for discussion. These alternatives are:

1. The management program should not give special attention to beach erosion since these processes are still only poorly understood and cannot be controlled. Economic losses may be defrayed by insurance and present municipal zoning standards and existing state and federal legislation are adequate to control the dangers of developing beach front lands.
2. The protection of some beaches and dunes is an issue of importance which should be addressed by the State coastal zone program, particularly in those shoreline segments where life and property are threatened or where wildlife sanctuaries or aesthetically pleasing natural settings must be preserved.
3. The protection of the State's shoreline is an issue of such dimension that New Jersey's coastal zone program will be unable to confront it without new State legislation.

The poor building practices identified in Volume II and summarized in Table 2 of this report indicate that not all of the communities have zoning standards which are adequate to insure against costly and dangerous misallocations of shoreline land use. (This factor was also noted in Cape May County Planning Board, 1976). This, combined with the consideration that the shoreline of New Jersey is a system of interrelated segments, each of which is dependent upon changes in the adjacent segment, implies that some state guidance is required. Accordingly, alternative (1) is believed to be inappropriate. The implementation of either alternative (2) or (3) is dependent upon the ability of local communities to recognize the magnitude of the beach management problem and work toward solutions which are compatible with the natural processes, are environmentally sound and are in the interests of state residents as well as local residents. The state coastal zone management strategy must therefore be concerned with the problems inherent to beach erosion and both site specific and regional policies are necessary in order to mitigate these problems. Potential state actions include:

1. Encouraging remedial measures such as artificial beach nourishment, dune stabilization, and the building, removal, or alteration of protective structures.
2. The development of additional regulations and suggestions dealing with the location of development. Areas with the highest instability or fragility have been identified (see Table 3). These areas should be given special attention.

3. The development of regulations and suggestions dealing with the control of recreational and resource utilization activities. Activities which adversely affect the natural stabilizing influence of the beaches and dunes or the ecological benefits of the beaches could be discouraged.

### Focus

Two recurring themes will be seen throughout the report. One is related to the need for the development or expansion of recreational beaches or improving access to these beaches. The second is the need to minimize the property damage and economic losses due to the destructive effects of storms or long-term erosion. Both of these involve direct protection of the shoreline itself, as well as the prevention or elimination of threatened structures or those which serve no beneficial function. Table 1 presents adjustments to coastal erosion which are aimed at the reduction of economic loss resulting from storm and long-term erosion. The table indicates that there are several different methodologies for attacking the problem. These range from suffering the loss of the structures (in some cases with economic compensation) to modifying the erosion hazard by protecting the buildings. There is, therefore, a broad spectrum of possible ways in which coastal erosion can be treated. It would appear from the table that the maximum input from State planners would be related to the modification of loss potential by zoning, building codes, and purchases of eroding land. However, both the adjustment to loss and modification of erosion hazards strongly affect shoreline land use in segments beyond the immediate erosion problem area. Therefore, it is clear that State guidance is required, regardless of the methodology adopted to reduce erosion hazards. State policies for these adjustments are articulated in greater detail later in this report.

Table 1. Adjustments to Coastal Erosion. Modified from Mitchell (1974).

<u>Adjustments to Loss</u>	<u>Modification of Loss Potential</u>	<u>Modification of Erosion Hazard</u>
Loss bearing	Coastal planning	Dune construction
Insurance	Building codes	Groins, jetties
Emergency public assistance	Public purchase of eroding land	Bulkheads, seawalls, and revetments
	Moving endangered structures	Breakwaters
	Installing deep pilings on buildings	Regulations against destruction of dunes and vegetation
	Storm warning and forecasting systems	Small-scale structures
		Emergency filling and grading

## CLASSIFICATION SYSTEMS

### General

The shoreline of New Jersey is characterized by a considerable variety of shoreline orientations and degrees of onshore development. It has been found useful to employ three different classification systems as a preliminary step in the analysis of the differences and similarities in beach behavior. These are identified as shoreline zones, beach categories, and individual beach segments. The systems are described in Volume II, page 3. The first classification system broke the shoreline down into five zones (Figure 1) which formulated the basis for generalization about the New Jersey shoreline as a whole. This classification system was used to present a general overview of beaches within the states, and it is not used in this volume.

### Beach Segments

The second classification represented an attempt to group beaches into categories based upon exposure to wave, wind, and tidal processes. This classification, in turn, served as the means of breaking the shoreline down into 51 smaller, discrete segments for a detailed analysis. Detailed investigations were conducted in each of these 51 segments. Section 4 of Volume II of this report describes these sections in narrative form. The process controls and present state of development which restrict land use within these 51 segments are presented in summary form in Table 2. Many of the problem conditions identified in the table are common to all beach segments to varying degrees. This factor, combined with the obvious need to reduce a complex problem to a more fundamental analysis has required the use of a more basic classification system.

### Beach Categories

A classification system of beach categories was developed, based on differences in exposure to ocean swell, locally generated bay waves, and tidal currents. The beaches were grouped into five categories which provide the basis for the discussion of management strategies presented in this volume.

Table 2. Summary table of conditions observed on the New Jersey shoreline which are important in assessing beach protection problems and selecting appropriate land uses.

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#### Bad Building practices or detrimental effects of man

Building on the flood-prone barrier islands.

Building on dunes.

Long, high, impermeable groins starving downdrift beaches.

Construction of bulkheads which are of insufficient strength.

Absence of dune walk-over structures.

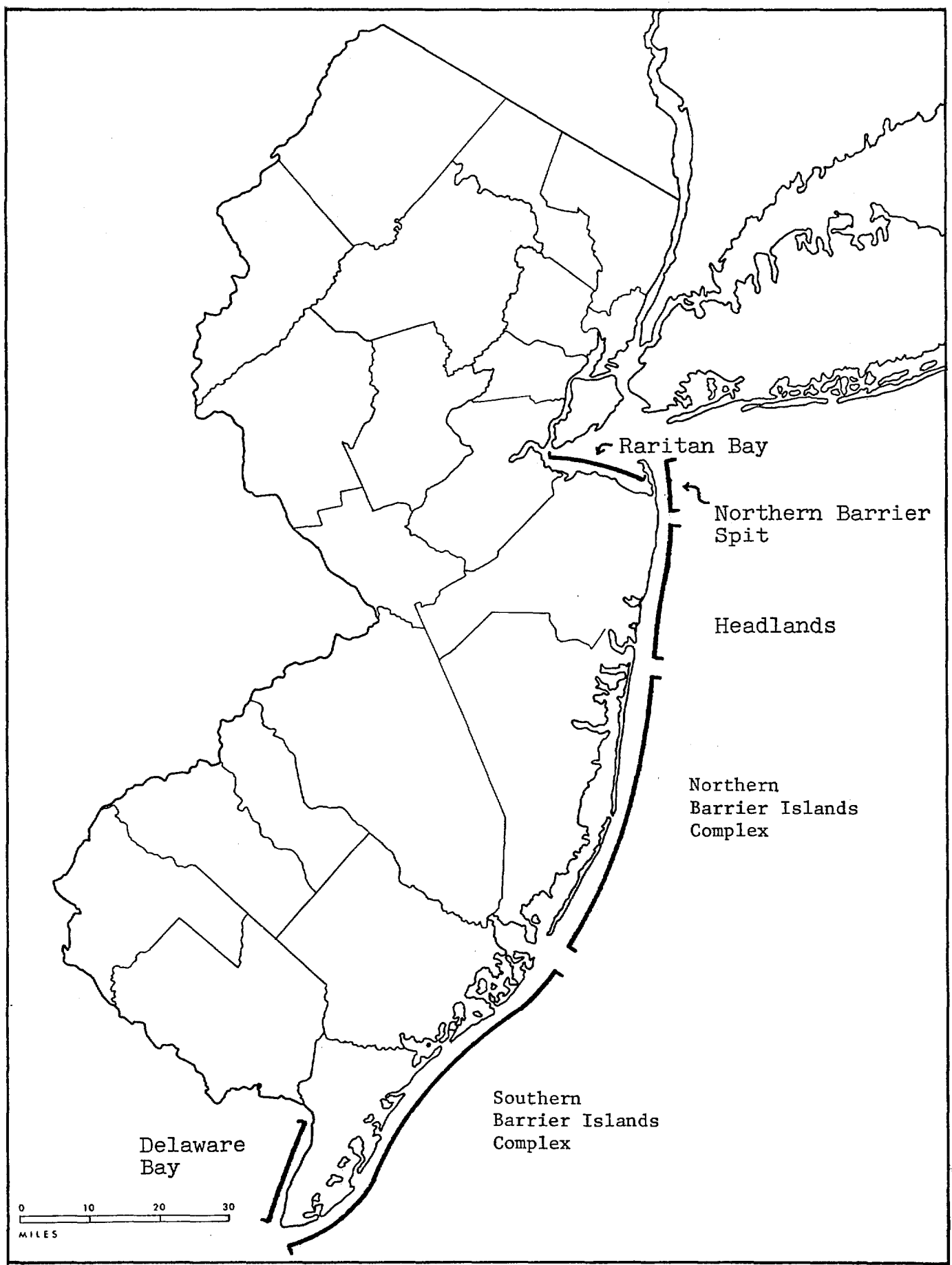


Figure 1. Identification of shoreline zones.

## Table 2 Continued

Bulldozing the dune to facilitate house construction or to provide a view of the sea.  
 Riprap structures not anchored by concrete cap.  
 The presence of large gaps in dune fields.  
 Widening the dune at the expense of the beach or lowering the dune and compensating for this by widening the dune.  
 Allowing people to walk on dune.  
 Building projects keeping pace with deposition.  
 Sacrificing dunes to maintain boardwalks flush with the backshore surface.

### Natural factors contributing to erosion

The absence of beach fronting seawalls.  
 Narrow beaches.  
 Absence of protective dunes.  
 Low backshore elevations.  
 Overwash of bulkheads.  
 Sand drifting over bulkheads into structures onshore.  
 The importance of tidal effects.  
 The importance of northwesterly winds and waves on bayside beaches and northeasterly storm conditions on oceanside beaches.  
 The presence of deep offshore channels.  
 The absence of sediments fronting beach protection structures.  
 Lack of vegetation on the dune.  
 Greater aeolian activity associated with finer grain sizes.

### Evidence of erosion

The absence of beach fronting seawalls.  
 Building set on pilings extending out from the foreshore.  
 Narrow beaches.  
 Evidence of destruction of protective structure.  
 Breaching/erosion of the landward end of the bulkheads or groin and seawalls.  
 Foreshore extending directly under boardwalk with on backshore.  
 Linear street patterns superimposed on curvilinear shoreline forms.

### Factors affecting land use

The absence of beach fronting seawalls.  
 Narrow beaches.  
 Absence of protective dunes.  
 Low backshore elevations.  
 The width of the beach in its relation to (1) dune creation and (2) a buffer against erosion of the dune.  
 The presence of road offsets with relatively natural areas downdrift to them.  
 Greater aeolian activity associated with finer grain sizes.  
 Widening the dune at the expense of the beach or lowering the dune and compensating for this by widening the dune.  
 Foreshore extending directly under boardwalk with no backshore.  
 Potential for island or spit breaching and inlet creation.

### Considerations requiring further investigation

Downdrift effects of beach protection structures.  
 The use and effectiveness of sand fencing.

## Table 2 Continued

The effects of beach vehicles.  
 Potential for island or spit breaching and inlet creation.  
 Building houses on the dune or pilings.  
 Widening the dune at the expense of the beach.  
 Examining beach fill alternatives.

These categories are identified by letter and are described below. Figure 2 identifies the shoreline forms and orientations which provide the basis for subdivision for the classification system. A summary description of the important process controls for each of these beach categories is presented in Table 5 where it forms the basis for discussion of the guidelines permissible for land and water uses for the shoreline.

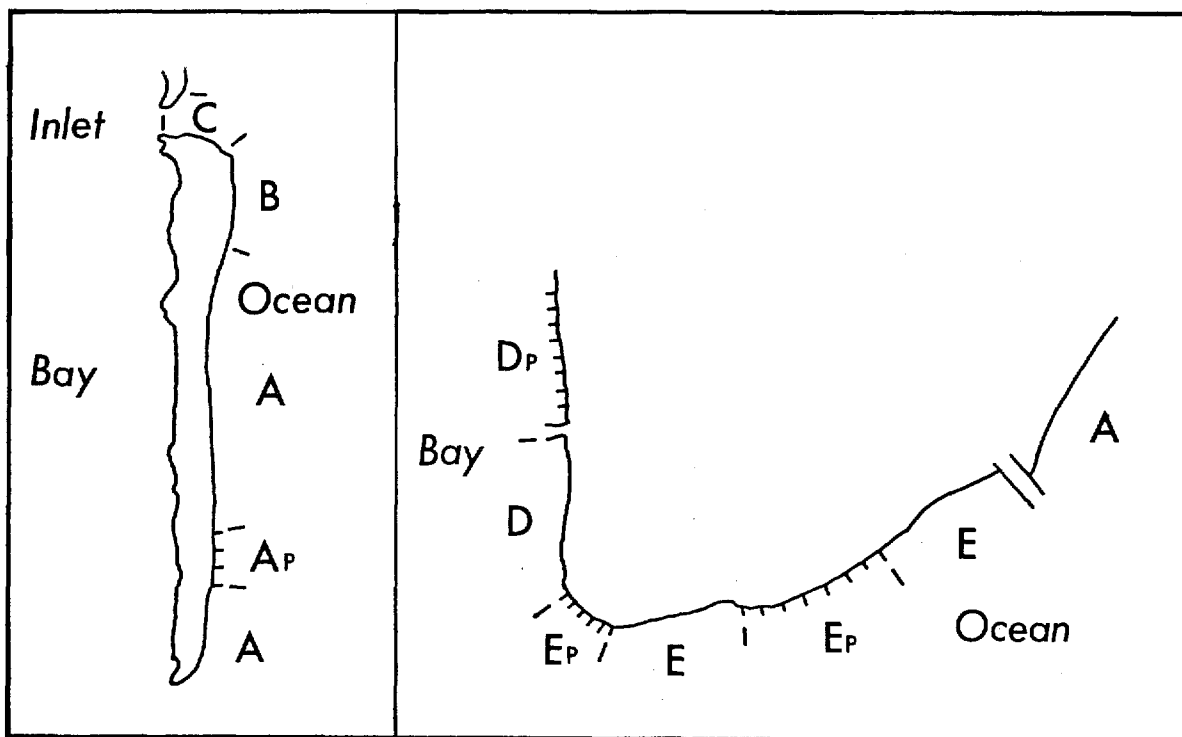


Figure 2. Categories of shoreline subdivision.

### Category A (Exposed Ocean Beaches)

These exposed ocean beaches comprise the bulk of the Atlantic Ocean shoreline. The shoreline orientation within these segments is essentially linear, favoring longshore transport. The dominant processes are ocean waves and wave-induced currents. (e.g. Long Branch).

### Category B (North-east Island Beaches)

These beaches are located at the north-east ends of the barrier islands where they are in a position to be noticeably affected by inlet processes. These beaches are characterized by a prominent seaward bulge in shoreline form. Ocean waves and currents interact with inlet tidal currents in a complex manner on these beaches. (e.g. the ocean beach at Atlantic City).



### Category C (Inlet Throat Beaches)

These are the inlet throat beaches located in the southern portion of the state on the northern side of the barrier islands. Here, tidal currents are dominant, although ocean wave effects are important, especially during storms. (e.g. the northern tip of Atlantic City facing Absecon Inlet).

### Category D (Bayside Beaches)

These are the bayside beaches which are characterized by low wave energies. Wave conditions are more variable on these beaches than on the oceanside due to the effect of rapidly changing local wind conditions on bayside wave generation. (e.g. Raritan Bay and Delaware Bay).

### Category E (Complex Beaches)

The category E beaches are the complex beaches located at the northern and southern termini of the ocean shoreline of New Jersey. They are subject to the effects of swell and bay waves, as well as tidal currents. (e.g. Cape May Point).

### Shoreline Environments

Beaches of a different category have different rates of long-term erosion or short-term mobility. These differences must be considered in assessing permissible uses for the beach, dune, and upland (coastal) environments. Accordingly, the shoreline has been stratified into these shoreline environments (see Figure 3). Permissible uses are then based upon the category of shoreline and the particular environment.

The three panels show differences in the dimensions of the environments which result from construction in the coastal zone. The first two panels show the immediate effects of construction which results in a lowering of the secondary dune to facilitate house construction or provide a view of the sea. The bottom panel shows how maintaining a fixed shoreline position under erosional conditions results in a restriction of both the beach and dune environments. The width of the dune is partially compensated for by increased dune height favored by sand fencing or dune grass planting. Because bayside environments are not treated in this report, there has been no attempt to differentiate nearshore, beach, or dune environments nor identify the effects of development on bayside sites.

Figure 3 presents an idealized cross section of a barrier island system. There are portions of the shoreline of New Jersey where the beach and dune environments are backed by a high, upland surface and the bayside environments do not exist. Accordingly, the term 'upland' is used in this diagram even though this location is often lower than the dune environment.

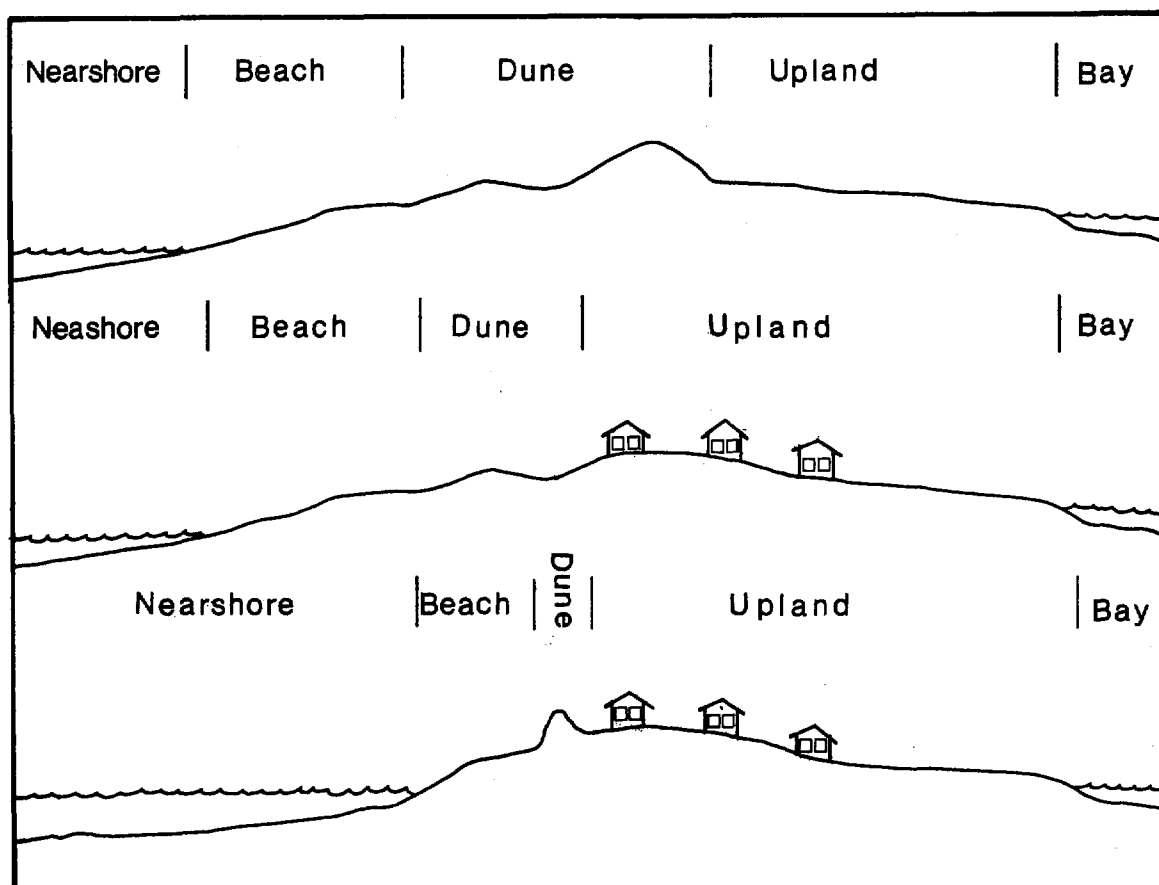


Figure 3. Schematic diagram of beach environments.

### Other Factors

A glance at Figure 4 reveals that the locations designated as areas of particular concern (see Table 3) are not confined to one region in the state. Further, these areas of concern are not totally related to the shoreline category but depend to a large extent upon the degree of shoreline development. Management strategies then are not strictly confined to protection from (or modification to) the natural environment, but require land uses regulations to reduce the potential for future erosion hazards. A comprehensive discussion of factors relating to improvement of wildlife habitat or consideration of the economic, political, or cultural preferences of shorefront residents or visitors is beyond the scope of this report. Nevertheless, recommendations have been made to reflect these considerations.

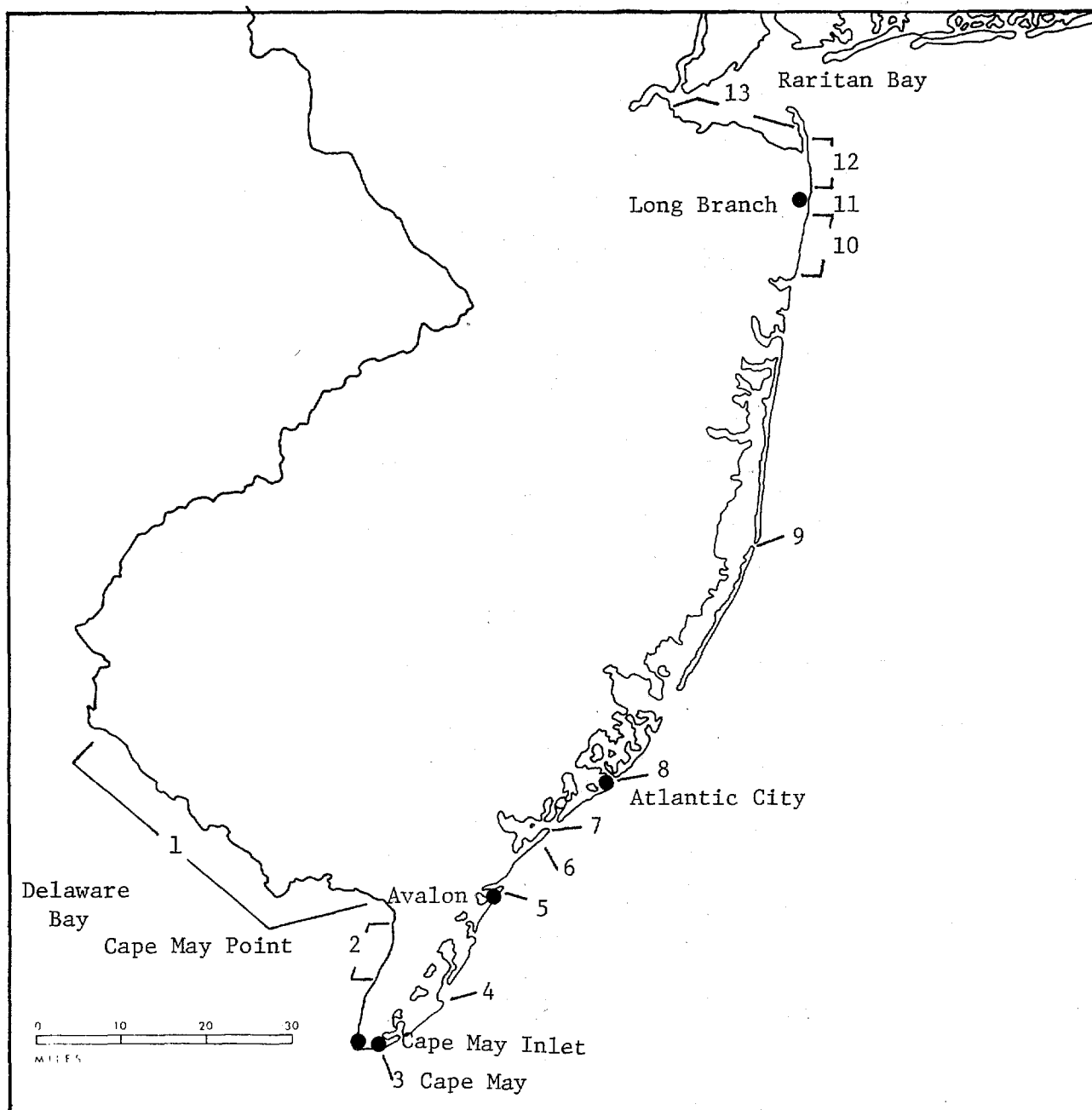


Figure 4. New Jersey showing place names used in text and erosional areas of particular concern. The latter are identified by number and are described in Table 3.

Table 3. Summary table of erosion areas of particular concern\*

A.P.C. No.	Segment No. (from Vol. II)	Area	Erosional Evidence
1	Delaware Bay	Cumberland County (developed portions along bayshore)	very narrow beaches with structures eroding away
2	1	Middle Township (developed portions along bayshore)	narrow beaches with structures eroding away
3	6	Cape May City (especially area between Wilmington and Ocean Aves.)	no beach at high tide
4	10	North Wildwood (where Hereford Inlet fronts beach)	narrow (or no) beach - waves break over seawall causing flooding problems
5	18	Strathmere (Putnam Ave. to end of developed island)	narrow beaches, high beach mobility
6	20	Ocean City (3rd St. to 18th St.)	narrow beaches, city can handle more visitors than beaches can
7	21	Ocean City (E. Atlantic Blvd. to Newcastle Rd.)	beach varies greatly with inlet dynamics
8	24	Atlantic City (where Absecon Inlet fronts beach, Oriental Ave. to Parkside)	no beach, water goes right under boardwalk
9	31	Barnegat Light (8th to 4th St.)	beach narrow because of inlet dynamics
10	36A&B except Long Branch	Loch Arbour to Elberon	narrow beaches - groins in state of disrepair
11	36B&C	Long Branch	needs attention because of narrow beaches and proximity to large urban areas
12	36D & 37	Seabright and Monmouth Beach	little or no beach, seawall in state of disrepair
13	44 - 51	Developed areas along Raritan Bay	very narrow beaches

\* See Figure 2 for location. These sites are discussed in greater detail in Section 5 of Volume II. Other minor areas of concern are also presented in that section.

COASTAL LAND AND WATER USES: GENERAL DISCUSSION<sup>1</sup>Recreation

Recreation is the most direct use that people make of the water's edge. Although much of the time spent on the beaches is for sunbathing and swimming, there are a considerable number of beach-related activities. Table 4 identifies possible recreation-related uses of the beach, nearshore, and dune district. These uses are somewhat restrictive because of the highly dynamic nature of the beach and nearshore environment and the requirements for protection of the dune district. Other uses, less compatible with shoreline dynamics or with the protective function of these environments, are presently practiced and could be listed. However, the list presented here is largely confined to uses which are not dependent upon structures, except for removable concession stands, lifeguard towers, and related structures. The only permanent facilities indicated are the amusement piers and boardwalks. These permanent facilities should be restricted to communities which are developed to handle a large number of visitors and where the aesthetic value or wildlife habitat functions of the shoreline are minimal.

Although the demand for public recreation has been increasing, opportunities have been declining. According to NRDC (1976) only 2 percent of the U.S. coastline is now available for public recreation and many of the most accessible areas are being lost to private development. It is, therefore, becoming increasingly important that the state consider the acquisition of property developer exactions, and other techniques for enhancing public recreational use of the beach.

Excessive recreational use may damage certain fragile coastal resources, however, and the management program should recognize this. The dunes, for example, are particularly fragile environments and cannot bear too much foot traffic. The management program should tailor the recreational use to the carrying capacity of the area, and the number of visitors that can be accommodated in a certain area must be computed to avoid overtaxing the resource, disturbing the natural protective function of the feature, or reducing its value as wildlife habitat.

Recreational activities which are not dependent upon permanent structures are very suitable in highly mobile and hazard prone areas. However, not all recreational uses may be consistent with the specific beach dynamics. Further, although beaches (ocean beaches in particular) possess opportunities for multiple recreation uses, some of these uses conflict (e.g. swimming and surfing). In

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<sup>1</sup> Many portions of this section are excerpted directly from National Resources Defense Council (1976). In addition to the six uses identified here, NRDC (1976) identifies uses for agriculture and power production. These are not considered important potential uses in the immediate vicinity of the beach, and they are not included in the present report.

Table 4. Possible recreation-related uses of beach, nearshore and dune district.

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#### Sports

swimming - including wading, surfing, rafts, etc.  
fishing & crabbing (private and commercial) - in surf,  
 from piers, groins, jetties, boats  
games - volleyball, "catch", kite-flying, etc.  
jogging  
boating (sailing and motor) - pleasure, fishing, commercial,  
 sightseeing  
beach-buggies \*  
diving - scuba and skin  
water skiing  
riding bikes (on boardwalk)

#### Relaxation

watching - people, sunrise, sunset, stars, lights on boats,  
 waves, ships, animals  
sitting - on benches, sunbathing, picnicking, reading  
socializing  
walking - beach and boardwalk, beachcombing, nature walk,  
 walk dog  
miscellaneous - feed seagulls, eat seafood, catch sand  
 crabs, amusement parks, camp (overnight & day), hunting,  
 building sand castles

#### Work

Life guards, beach patrol, park rangers, fishermen, maintenance  
 people, badge checkers, concession stands

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\* This use is felt to be incompatible but is left here pending investigation of the effect of vehicles on beach behavior.

other areas, municipal ordinances may restrict or prohibit some activities. Private residences, large-scale beach front condominiums, or hotels also limit access to a privileged few in areas which could be available to all and for a variety of uses.<sup>2</sup>

The development of beaches for recreation should also be evaluated for the total impact on the shoreland in surrounding areas. Although recreation may be suitable from the standpoint

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<sup>2</sup>Legal access to both the wet and dry sand beaches, public and private, and to the seawalls, jetties, and groins should be more clearly defined (New Jersey Beach Access Study Commission, 1977). That study urges the enactment of a comprehensive beach management law to address the right of public access, the protection of private property, and the ground rules by which municipalities can manage public beaches and pay for their maintenance. The Coastal Zone Management Act amendments of 1976 also call upon states to develop planning processes for protection of and access to public beaches and other public areas.

of beach dynamics, these activities may conflict with use of the beach as a wildlife habitat. More extensive recreational use may also have adverse effects upon transportation patterns and place undue stress on inland facilities.

### Commercial Fisheries

Harvesting, processing, and marketing of fish is a major economic activity in New Jersey. However, this use is not dependent upon the immediate area of the beach. The development of the beach can have adverse effects on fisheries, especially in the contribution to water pollution. Inlet dredging can also have implications to fishing, since the access to the ocean for fishing boats will be affected. A related use - shipping - is less affected by development of the beach, although possibilities for oil spills can have an effect on recreational use of an area. The dredging necessary for large vessels may also supply beach fill. The issues identified above are only marginally related to beach dynamics and are not treated in this report.

### Industrial Use

Some industries are located on waterfronts because of a need for access to water transportation or cooling water. Most, however, do not require waterfront locations and are there because of the low cost of coastal lowlands, easy access to markets, and inexpensive sites for waste disposal afforded by coastal waters. New industrial development is now being directed away from vital natural areas or areas of environmental concern on the coast and industries which are not coastal-dependent are required to site their facilities inland. Location in the immediate vicinity of the beach environment appears to offer no advantages to industrial use. The emplacement of such features in a hazard zone would greatly increase the scale of economic loss of shorefront buildings.

### Mining

Potential mining activities in the vicinity of the New Jersey beaches appears to be confined to the removal of sand and shells. At present, the removal of material from the beach is prohibited. However, there is evidence of local abuse of this regulation.<sup>3</sup> The removal of sand from the beach diminishes its protective effect while removal of material from the bluffs behind the beach increases the probability of bank failure by reducing the structural support of the embankment and its vegetation cover.

### Residential Use

The beach/dune system and the barrier islands offer no unique engineering advantages over upland locations for construction of

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<sup>3</sup>Material is periodically removed from the beach to provide fill behind bulkheads and material which is washed or blown over the bulkheads from the oceanside to the landward side may be legally removed to inland locations.

residences. Indeed, house construction in the vicinity of the beach may be more difficult due to relative isolation from transportation networks. The prime reason for construction in the dune area is the unique opportunity afforded to the occupant of readily available beach related activities.

Beach front construction has four main disadvantages:

1. development into private lots restricts public access to the beach;
2. valuable protective dunes and dune habitat is destroyed;
3. the potential for economic loss is increased;
4. this development represents an irreversible commitment, and future land use options are severely restricted.

Although a major issue, Item 1 is not directly related to beach mobility and is not discussed here. Items 2 and 3 are related to the dynamics of the beach system and they warrant further discussion. Most would agree that prohibiting construction of residences in an erosion hazard area is proper management. However, the actual identification of a hazard area is not so easy. Some areas without a previous erosional history may be eroded severely during a particular storm. The lack of documentation of erosional conditions will severely hamper efforts to restrict development in such areas. A clearly demonstrable hazard in some areas, however, indicates that regulations against shorefront construction can and should be applied here.<sup>4</sup> The unique and fragile nature of the barrier island system is well documented. Prohibiting all but water dependent and limited recreational structures is, therefore, considered to be proper management.

### Wildlife Habitat

All physical components in an ecosystem are interdependent. If a physical process is altered, a chain reaction can occur that will disrupt all the species living in that environment. The coastal zone management program must recognize this interdependence and strive to preserve the natural balance. Otherwise important resources, some of which have tremendous economic value, will be lost. Construction activities in the beach environment (not only house construction, but also the construction of seawalls and groins) can severely interfere with the natural processes as well as result in direct habitat destruction. For example, the construction of a seawall, if not accompanied by groin construction and the use of beach fill, will eventually result in the complete removal of the beach environment from the area, thus having a dramatic effect on the regional mix of wildlife. Certain species of wildlife are well suited to live in a rapidly changing, highly mobile beach environment and this land use is particularly well suited to such areas. Attempts by man to control beach processes in such areas may result in the eventual destruction of the habitat without even achieving

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<sup>4</sup>Specific requirements for shorefront construction, may include setback requirements, building houses on pilings, flood insurance requirements, etc.



the desired beach protection, resulting in a nonproductive land use.

## GUIDELINES ON PERMISSIBLE LAND AND WATER USES

### Land Use Planning

Great competition among shoreline activities on a limited land resource base requires a management program which will adjust the best possible land use to each of the different shoreline environments. Many uses are not equally efficient in the different environments, so site-specific alternatives must be evaluated. The shoreline of New Jersey is characterized by both oceanside and bayside beach environments. Erosional conditions characterize many of the ocean beaches but depositional conditions can occur on the beaches at the inlets and in specific groin fields. Most of the bayside beaches experience slow but persistent erosion. This offers a very wide array of environments which presents many problems and choices to coastal zone managers.

Ideally, development should proceed without conflict of interests or profit incentives. However, these ideal conditions are not possible, and the use strategies identified here, can only serve as an idealized, basic model for coastal zone management. The following general guidelines on permissible uses are suggested:

1. The development of barrier islands must be severely restricted and limited only to those activities which require location in this dynamic and flood prone environment.
2. Most recreational uses and work-related uses which do not require fixed structures or vehicles will be suitable to all beach environments.
3. Recreation activities in the dune districts should be severely restricted due to the fragile nature of these environments.
4. The mobility of the beach/dune environment and the rate of migration inland should be clearly understood and these factors should be considered in the method of construction and the useful life of any structures near this location.
5. No permanent structure should be constructed on the beach.
6. Any construction activities in the dune districts should be severely restricted to only those activities which require this unique setting.

7. If structures must be built here, these should be built on pilings to prevent interference with natural processes.

#### Permissible Uses by Beach Category

Suggested land and water uses for each category of segment are presented in summary form in Table 5 without comment. The rationale for these suggestions is developed in the discussion of each individual segment presented in Section 4 of Volume II of this report. Other concepts are developed below in the discussion of construction in the beach, dune, and upland environments.

Table 5. Summary table for permissible land and water uses by shoreline category

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#### Category A (Exposed Ocean Beaches):

##### Process controls

- Linear orientation favors longshore transport.
- Dominant processes are ocean waves and wave-induced currents.
- Highest storm and swell energies of any category of beach.
- Most rapid short-term modification.
- Cyclic (onshore-offshore) beach response.
- Offshore gradients and wave refraction important energy filters.

##### Recommended land use

##### Beach environment:

- Most day use recreational activities are appropriate on all beaches.
- Overnight use and fixed structures (amusement piers) appropriate to presently developed Category A beaches with low mobility rates.
- All wildlife habitat preservation uses appropriate.
- No fixed structures - seasonal structures only where intensive recreational use.

##### Dune environment:

- Limited dune walk and beach access trails -- dunes behind.
- Category A beaches too narrow and fragile and important as form of protection for intensive use
- Uses as wildlife habitat appropriate
- Buildings should not be allowed but if they are, should be on pilings.

##### Upland:

- On non-barrier island beaches, all uses applicable behind beaches with low mobility rates or low long term rates of erosion.
- On barrier islands, all non-structural uses appropriate.
- Structural uses where required, but these should not interfere with dynamic barrier island processes.

Category B (Northeast Island Beaches):

## Process controls

Noticeably affected by inlet processes.

Bulbous form.

Bi-directional shoreline orientation.

Complex interaction of ocean waves and currents with tidal currents.

Form of inlet shoals has pronounced effect on wave refraction.

Reversal of sediment inputs into southern contiguous segments.

## Recommended land use

Beach environment: - same as Category A beaches

## Dune environment:

This area is generally more extensive than in Category A beaches. Accordingly, more useful for recreation and wildlife habitat. Otherwise, similar to Category A beaches.

## Upland:

High and unpredictable mobility implies development should be restricted. See high mobility Category A beaches above.

Most of these areas intensively developed but temptation to build industrial, commercial, and residential structures should be resisted.

Otherwise, same as Category A beaches on barrier islands.

Category C (Inlet Throat Beaches):

## Process controls

Tidal currents dominant.

Ocean wave effects important during storms.

Effects of channel migration.

Bayside sediment sources limited.

Inlets trap sediments from adjacent Category A beaches.

## Recommended land use

## Beach environment:

Beach-related activities severely restricted by narrow or non-existent beaches (sports, Table 4, largely inappropriate).

## Dune district:

Largely non-existent. Where they exist, protection should be required. See Dunes, Category A segments.

## Upland

Stabilization of inlets implies stabilization of category C shorelines requiring extensive protection structures (largely seawalls and bulkheads). Accordingly, upland land use similar to Category A segments on barrier islands with low mobility or low erosional rates.

Category D (Bayside Beaches):

## Process controls

Wave conditions more variable - effect of locally changing wind conditions.

Higher wave steepness.

Mechanisms for natural return of sediments through swell waves is severely restricted.

Tidal currents can be an important process.

Scale of erosive forces is smaller.

Narrow beaches limit dune formation, broad, flat offshore shelves.

Foreshore sediments are coarser and they contain more lag gravels.

## Recommended land use

## Beach environment:

Size, appearance, and quality of beach limit recreational activities, especially sports.

Wildlife habitat appropriate. Construction inappropriate.

## Dune environment:

Small-scale features of limited value for protection or for recreation. Wildlife habitat is most appropriate.

## Upland:

See Category A non-barrier island beaches; wildlife preservation on salt marsh.

Category E (Complex Beaches):

## Process controls

Subject to effects of swell, bay waves, and tidal currents.

Different effects of storm waves on even adjacent beaches.

May be erosion or deposition depending on unique characteristics at each site.

## Recommended land use

All uses of the beach and dune system are site specific. For upland use, see comments under Category A beaches.

Permissible Uses by Shoreline EnvironmentConstruction in the Beach Environment

Beach and dune environments are subject to considerable re-working by natural processes. The beach, in particular, is very mobile and virtually the entire upper surface of the beach is re-worked during each storm season. This high mobility would jeopardize any structure located there and associated economic losses would be high. The beach also acts as a protective buffer

zone between the water and the upland. Construction here would restrict the width of this buffer and allow high wave energies to more closely approach onshore structures. Construction on the beach also interferes with deflation and the dune-building processes. Accordingly, all permanent or "semi-permanent" structures should be prohibited from the beach environment.<sup>5</sup>

#### Construction in the Dune Area

Dunes provide a natural protection against flooding and also a reservoir of sand to replace that lost on beaches during extraordinarily severe storms. The dune environment, like the beach environment, is very dynamic and subject to periodic inundation and wave attack. Dunes also provide wind-blown sand to the ocean beach/nearshore system during periods of northwesterly winds. Construction in the dune environment is less directly hazardous to the structures themselves than construction on the beach. However, the inevitable destruction of the protective value of the dune against storm overwash must be considered. Because of the direct hazard to buildings and the interference with the protective effects of the dune (for structures farther inland) construction in this district is not recommended.

#### Construction in the Upland Environment

Barrier Islands - The upland on barrier islands is, under natural conditions, highly dynamic and in many cases the dune/overwash district may extend over the entire width of the island. The importance of maintaining a natural barrier island configuration has been demonstrated by Godfrey and Godfrey (1973) and Dolan 1973. Important considerations are: protection of the mainland from flooding, maintenance of adequate dune widths, periodic creation of salt marsh habitat, ecological advantages, and recreational benefits. Numerous agencies now are taking steps to preserve the barrier islands from development. Development on these islands should be severely restricted and limited only to those activities which require location in this dynamic and floodprone environment.

Mainland - In many places, the beach is backed by mainland upland surface. These areas are normally of sufficient elevation to experience little direct damage from waves and storm surges. However, in most areas, wave processes, combined with a rising sea level have resulted in a continuous landward migration of the upland/beach contact which eventually results in a cliffing of the land upon which the structures are built. This leads to their inevitable destruction. Construction practices should reflect a thorough understanding of the migration of this hazard zone.

A major endeavor of the Coastal Zone Management Program should be to identify these hazard areas, their rates of migration, and the limits (and rate of migration) of the dune district. This would be a first step in suggesting (and possibly regulating) how construction on the shorefront is to proceed.

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<sup>5</sup>Construction on the beach would also considerably reduce potential for recreation of the area. However, this is not related to beach dynamics and is not discussed here.

## Conclusions on Construction in Beach-Dune-Upland Environments

From the preceding paragraphs it will be apparent that construction of any permanent facility is not compatible with the dynamics of the beach/dune system. The direct prohibition of all such structures from these environments is perhaps unrealistic at the present time but should be viewed as a long-term goal. In the short-term, it may not be feasible, economically and politically, to prevent construction on the upland behind the beach/dune system, except in those areas where a definite hazard is expected to occur in the near future. This depends upon the mobility of the beach which is related to the category of the beach and its geographic location in the state. Decisions will, therefore, have to be made on an individual basis.

### METHODS FOR EROSION CONTROL, MITIGATION, AND/OR RESTORATION

#### State Policies

Considering the limited funding available to State agencies for erosion mitigation and restoration, these policies must establish some priority. It is expected that many factions will be competing with each other for State help in many cases. It is, therefore, imperative that the State policies be based upon sound physical principles to insure that primary effects are directed towards the major problem areas.

With increasing emphasis on the environmental effects of construction in the coastal zone, whether it be dwellings or beach protection measures, it is clear that State policies developed in New Jersey and other states as little as five years ago are no longer appropriate. These policies need updating. For example, it is now recognized that buildings which are destroyed by wave attack should not be built on the same site where they were, regardless of whether beach protection structures can be applied to protect them. Also, structural alternatives such as groins are now in less favor than previously. The development of State policies is also clearly interlinked with the guidelines established on priority uses and permissible land and water uses and with the mechanisms for dealing with problems on a continuing basis. These policies must also dovetail with the efforts of local and Federal agencies. Accordingly, the efforts of these other agencies are identified in the next section.

The considerations for policy development are presented in outline form below. The formulation of specific policy state-ments requires a thorough examination of the economic and environmental controls operative, as well as the interests of local groups and the policies of the other governmental agencies charged with regulating land use in the coastal zone. The following points are relevant to the beach and dune environment:

1. Policies should be compatible with the plans of other agencies.
2. Plans should be tailored to the physical processes which are operative.
3. Economically realistic plans should be stressed.
4. Multiple use inlet maintenance/beach nourishment schemes should be stressed, as well as other beach fill possibilities.
5. The state should provide guidance of local communities through a public awareness program in regard to:
  - a. identification of hazards and methods of controlling them (a clear distinction should be established between inundation and erosion damages since their long-term effects are substantially different)
  - b. beach protection techniques
  - c. the importance of dunes and buffer zones
  - d. proper building practices
  - e. the implications of development of the beaches in a community to adjacent communities.
6. The state should encourage the communities to do what they can to help themselves but provide assistance when needed.
7. Priorities should be given to public safety and welfare. A second order of priority should be given to areas of particular concern. Consideration should also be given to improvements in areas experiencing economic stress due to loss of recreation beaches.
8. Contingency plans for emergency restoration and protection of beaches and dunes should be re-evaluated and updated.
9. Plans should consider the common good, and local interests should not be favored.
10. Aesthetically pleasing natural settings and wildlife sanctuaries should be identified and preserved.
11. Policies should stress the importance of beaches for both protection and recreation.
12. Steps should be taken to establish dune preservation zones or buffer zones.
13. Policies for the development of hazard lands should be developed for incorporation into official plans of all shoreline municipalities.

14. An acquisition policy related to lands with hazard characteristics should be developed.
15. The state should implement measures to insure that the communities and private citizens follow proper standards.

#### Existing Federal and Local Efforts

##### Efforts of the Corps of Engineers

As noted in Cape May County (1976), the critical beach erosion and inlet maintenance problems of New Jersey have been the subject of exhaustive and comprehensive Corps studies. After thorough study and public meetings, the Corps considers alternative remedial plans and recommends the most feasible plan. After a series of public presentations at various stages of planning, design, environmental assessment, and engineering, followed by internal Corps and administrative reviews and approvals, the selected plan is implemented. The entire process may require from five to ten years and consists of at least twenty-two actions involving the general public, public officials at the local level, the Congress, and a number of Federal officials in various agencies. The Corps of Engineers has assumed responsibility for long-range planning for beaches and inlets, but is not responsible for plan implementation until project authorization and conclusion of cost sharing, real estate, maintenance, and land use restriction agreements with state and local governments.

The Corps of Engineers thus functions as the primary coastal project planning agency. The cost of planning, design and engineering in itself would be prohibitive to local government, and the Corps has experience in project testing and construction stages not available elsewhere (Cape May County, 1976, p. 23). The nature of the improvements suggested by the Corps of Engineers for portions of the New Jersey shoreline may be found in Table 6.

Table 6. Range of potential improvements for the New Jersey inlets and beaches suggested by the Corps of Engineers.

1. Construction of weir type jetties on the updrift side of inlets (creation of a sheltered deposition basin by construction of a breakwater with a weir section for inlets already protected - e.g. Cape May).
2. Dredging of navigation channels through inlets.
3. Construction of jetties and bulkheads on the downdrift side of inlets.
4. Placement of sand spoils behind the downdrift jetties and bulkheads.



5. Construction of new groins.
  6. Maintenance of existing groins.
  7. Periodic dredging of proposed deposition basin adjacent to the updrift jetties for purpose of providing nourishment for downdrift beaches.
  8. Placement of sand to build beaches and dunes.
  9. Rehabilitation of portions of seawall undermined by erosion.
  10. Construction of dikes to prevent flooding from adjacent low lying areas.
  11. Maintenance of existing dikes.
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#### Other Federal Efforts

Insurance - Since the 1973 expansion of the National Flood Insurance Act of 1968, adoption of insurance against erosion has experienced a dramatic increase. This has resulted from extension of the federally subsidized flood insurance program to encompass storm-caused erosion losses. Single family residences can now be insured up to \$70,000 and multi-family homes for up to \$200,000 at low premium rates.

There are no clear guidelines by the Federal Insurance Administration to determine whether erosion losses are caused by storms (avulsion) or by long term processes (erosion). Only the former qualifies for reimbursement. Considerable delays occur between a community's acceptance into the "emergency" phase of the program (minimum land use regulations required) and its passage to the "regular" phase where strong land use controls are required (NOAA, 1976, pp. II-34,35).

Presidential declarations - These can make disaster aid available to erosion victims and Public Law 93-288 also provides emergency aid if erosion is associated with storms (NOAA, 1976).

#### Municipalities

Land use regulation by the coastal municipalities includes zoning ordinances, dune ordinances, and building regulations. Zoning is the most widely applied regulatory mechanism. Most municipalities zone the shorefront for residential or recreational use. In Atlantic City, the beach was deeded to the city for use as a public park. Some municipalities are attempting to acquire beachfront properties under the New Jersey Green Acres program for use as open space and recreational areas.

Most of the municipalities with well-developed dune lines recognize the value of these dunes in erosion control and flood preservation and are taking measures to protect and maintain them either by ordinances (forbidding breaching, removal of sand or vegetation, walking, riding, etc.) or by making dune areas into parks (as in Avalon).<sup>6</sup> Very few communities have regular maintenance programs, but most will plant vegetation and erect sand fences, when necessary, as do many private land owners. Another approach to coastal land use control used in New Jersey is the establishment of construction set-back lines. Almost all of New Jersey's coastal communities require set-backs at varying distances from the dune line, surf line, major N-S road, etc. Most municipalities now require a minimum first floor elevation (above 100-yr. flood) as well as pilings. These are necessary in order to be accepted in the National Flood Insurance Program.

### Private Citizens

Local interest parties have employed small scale, low cost, protective measures with varying degrees of success. Such protection methods only treat the local problem area and may create problems down-drift of them. Policies should be established to limit the use of unproductive or counterproductive small-scale protection methods while advocating the use of proven methods. This should be tied into the public awareness program identified on page 23.

Adequate beach protection is often beyond the means of individuals, and larger engineering structures are often paid for by local, State, and Federal funds. Such projects usually stipulate that the beaches be open to the public. This requirement is not always favorably received, particularly if the owner is required to pay property tax on the beach. Policies must, therefore, be established which protect the individual property rights.

### Mitigating Measures

#### Modification of Property Loss Potential

Housing Construction - It may not be feasible to prevent shorefront construction except in those areas where a definite hazard is expected to occur in the near future. The hazard potential depends upon shoreline mobility which is related to the category of the beach and its geographic location in the state.

The beaches themselves are very mobile and virtually the entire upper surface of the beach is re-worked during each storm season. This high mobility would jeopardize any structures located there and associated economic losses would be high. Consequently, no structures should be allowed on the beach.

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<sup>6</sup> Unfortunately, there is no mechanism to prevent the bulldozing of dunes higher than the minimum down to lower levels to ease home construction.

Construction in the dune environment is not recommended because of the direct hazard to buildings and the interference with the protective effects of the dune. In areas where beach structures have been discouraged, there should be no adjustment to property loss either for beach, dune, or upland areas. Buildings which are destroyed by wave attack should not be rebuilt in the same location regardless of whether beach protection structures can be applied to protect them.<sup>7</sup>

Housing construction may occur without completely eliminating the protective effects of the beaches and the dune environments. Buildings constructed on pilings offer less interference with dune processes. They may also be located high enough to prevent damage due to storm surge. Through eventual inland migration of the beach/dune system, these buildings may eventually fall into the water. Buildings on pilings may last a considerable amount of time, even over the water, as have the amusement piers on many of the oceanside resorts and also numerous buildings on Delaware Bay. Under present natural conditions, with a rising sea level, eventual destruction of these buildings is inevitable, however. Damages associated with the direct loss of structures could also be kept to a minimum by building smaller removeable structures which could be relocated inland during storm periods.<sup>8</sup>

Both of the suggestions given above imply that buildings built at the shoreline will be smaller and thus, of lower unit value than they have been in the past. This does not mean that these structures could be written off and abandoned. Indeed, much of the destruction of buildings during storms occurs as a result of the large amounts of flotsam in the water which represents the remains of previously destroyed buildings. This flotsam is also a hazard to recreational use. Accordingly, provision should be made for all structures to be removed when they present a definite hazard.

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<sup>7</sup> Redevelopment of urban areas damaged by coastal storms may be considered permissible by the state. Redevelopment in suburban areas damaged by coastal storms should be severely restricted, however. To avoid hardship to homeowners in those circumstances, insurance should be carried by property owners in hazard zones sufficient to purchase new building sites and fund new construction outside the hazard area.

<sup>8</sup> Even removable structures should not be located on the ground in the beach or dune environment where they would interfere with the natural processes.

Dune Preservation - The identification and subsequent protection of the dune district is an issue of great importance.<sup>9</sup> It is here that the confrontation between man and the sea has resulted in the greatest expenditures for protection from erosion and where the greatest losses from wave attack occur. Destruction or lowering of this barrier may also increase economic losses landward of the dune due to increased flooding. Since this dune district is a favored location for shorefront construction, state managers may expect to encounter a considerable amount of opposition to their attempts to preserve these districts by local developers. A further complication results from the continued landward migration (in places) of the beach profile through erosion which will continually bring other structures within the limits of the dune district. Complications also arise over the definition of the dune district in developed portions of the shoreline.<sup>10</sup>

A more strict attitude toward zoning may be required to overcome some of the poor standards in the local communities. This is a natural extension of the policies establishing a dune district. The new standards should be designed to reduce the damage potential to structures (e.g. houses on pilings) as well as eliminate damage to the protective dune. The zoning standards should reflect the process controls as much as possible to reduce the legal difficulties (with local interest groups) or conflicts with other standards of zoning (e.g. by the flood insurance program).

Other Land Use Controls - A wide range of other land use controls also exists. These include moratoria on buildings, construction decision-criteria, setback lines, subdivision regulations, sand removal ordinances, graduate and tax assessments, transfer of Development Rights, Planned Unit Development, sanitary codes, and permits for special uses.

However, care should be taken that the State not exercise too much control over the local communities in their requirements for land use. There has been an increasing trend in recent years for more Federal and State interference in the activities

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<sup>9</sup>The New Jersey Beach Access Study Commission recommended legislation to require State delineation of a protective dune line and prohibition of development seaward of the line.

<sup>10</sup>A methodology for the identification of the dune district based upon beach dynamics is the subject of a proposal submitted by CCES, Rutgers University to the Office of Sea Grant. Cape May County (1976) suggests that shore front land on which property may be destroyed in future storms could be confiscated by federal law. Barring a catastrophe, the buffer zone would serve to delineate an area in which gradual formation of dunes would be encouraged.

of the communities and local citizens.<sup>11</sup> Legislation should be required only if the communities and local interest groups fail to employ the proper measures to insure proper coastal zone management. Accordingly, the level of state involvement will depend upon the activities in the individual communities, and at this point it is not clear whether alternative 2 or 3 on page 3 will be appropriate.

#### Modification of Erosion Hazard

Sand Recycling - Cape May County Planning Board (1976) points out the importance of using sand from inlets and offshore shoals as an alternative to static structures. This alternative offers protection to the eroding upland and improves the recreational potential of the beach. Although the beach fill is costly and requires a long-term commitment, the long-term rewards may be considerable. The initiation of a beach fill project at Long Branch, for example, should accomplish the dual objective of providing protection to the upland in the immediate vicinity, establish a feeder beach for nourishment of downdrift beaches, and increase visitor use of a resort which has been experiencing a relative decline. The use of weir jetties by the Corps will facilitate sand transfer at inlets. Increased use of inlet channel and offshore sediments, however, must await improvements in dredging technology. The State should express their interest in the rapid development of these advances in dredging to the Corps, and future policies should be developed with this increased opportunity for beach fill in mind.

Structural Alternatives - Many of these improvements consist of static measures, such as jetties and groins. Cape May County Planning Board (1976) points out the people's preference for these permanent structures which give a feeling of security, even though they do not always accomplish the desired objectives. Where structural alternatives are employed, care should be taken that they do not have an adverse effect on downdrift beaches. (The effect of the Cape May Inlet jetties and the high impermeable groins in the northern portion of the state were noted in Volume II.) Further, all other alternatives (both new and traditional) should be investigated before static measures are considered. This will require keeping up with the state of the art in shore protection and planning, and strategies should not be dismissed because they have not been practiced in the past.

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<sup>11</sup>The recent success of the Eagleton amendment to the National Flood Insurance Act was seen to be attributed to the pressure on Congress to be more relaxed on the Federal presence in the lives of individuals. This amendment favors loans for construction in flood hazard areas. It is cited here only to call attention to the problem of increasing governmental influence (see Coastal Zone Management Newsletter "Nautilus" vol. 8, no. 25, June 22, 1977).

MECHANISMS FOR DEALING WITH EROSION-  
RELATED PROBLEMS ON A CONTINUING BASIS

General

Federal, State, and local governments, as well as private citizens have invested more than \$50 million since 1960 in their efforts to prevent shoreline erosion, protect property, and maintain sandy beaches. Opinions vary on the effectiveness of several decades of incremental and disjointed shore protection efforts in New Jersey (New Jersey Beach Access Study Commission, 1977). The high degree of interrelationship among beach segments in New Jersey and the relatively small length of its shoreline imply that a comprehensive plan of shoreline management is both desirable and practical. This section presents a brief outline of the mechanisms presently used in dealing with erosional problems and suggests how these mechanisms may be re-evaluated for their suitability in future operations in the state. The methodology suggested could be employed by an expanded Office of Shore Protection.

Table 1 presents (in capsule form) some of the adjustments to coastal erosion. The specific methods of implementing some of these adjustments is indicated below in outline form and discussed later in the text. The specific methods are:

1. The identification of sources of information
2. The establishment of a mechanism for keeping up with the "state of the art"
3. The establishment of a mechanism for obtaining information from communities and citizens
4. Devising a system for processing and evaluating this information
5. Establishment of a surveillance system for identifying future problems
6. A system for periodic investigation of areas of particular concern
7. Establishing a mechanism to insure rapid relief in areas which may develop into larger areas of concern
8. A program of monitoring beach protection structures to insure their proper function
9. A provision for altering, as well as constructing, beach protection measures
10. The planning, establishment and maintenance of sediment recycling schemes
11. The establishment of an advisory service to disseminate

information on proper building practices and to provide guidance for beach protection structures built by private funds

12. The establishment of a hazard warning system
13. The development of contingency plans for post-storm reconstruction (or non-reconstruction)
14. A policy of public land acquisition and relocation of threatened structures

### Background Studies

The first step in a comprehensive program for dealing with problems on a continuing basis is the identification of the sources of information through a thorough literature search. This should include literature on beach processes, protective methods, and methods of predicting locations of erosion. Theoretical and empirical models of beach processes must be studied to determine the responses expected of beaches to individual storms and long-term changes resulting from adjustments to changes in wave climate. Differences in beach response on ocean and bayside beaches and protected and unprotected beaches must also be clearly understood. A preliminary step in this information search is the identification of all of the departments and agencies responsible for developing and presenting latest techniques in shoreline management. Publications of the Coastal Engineering Research Center and Waterways Experiment Station and other research centers should be examined, as well as published articles in journals dealing with geology and coastal zone management. Most of these reports will be theoretical or will be concerned with beach response in other locations. These must, therefore, be supplemented by case studies conducted in New Jersey.

The above sources should be examined for improved methods of long- and short-term beach protection. Both new and traditional methods should be examined to include sand bags, Longard tubes, and other structural adjustments (weather modification to reduce storm effects, floating breakwaters, etc.), even though some of these may be in experimental stages or have only site specific utility. Efforts must be made to keep up with the "state of the art" in these methods; therefore, a mechanism should be established for periodic updating of these reference materials. This may require the employment of a staff specialist, bibliographer, or technical consultant.

To put these sources in perspective, a working data bank on New Jersey should be established and periodic field work should be conducted. General descriptive studies of the wide variety of conditions affecting beach response on the New Jersey beaches

should be conducted, as well as site specific studies of areas of particular concern. The data from these studies may then be used to determine the degree to which each problem area is unique and the beach protection structures implemented may be tailored to the processes operative.

### Surveillance Systems

A mechanism should be established for obtaining information from communities or local interested citizens who may be more directly familiar with problem areas than personnel on the state planning staff. In this manner, small-scale incipient erosional trends could be identified and brought to the immediate attention of State officials. A system must be devised for processing and evaluating this information. It is assumed, that given the limited expertise of individual citizens, there will be many "false alarms" reported to the Office of Shore Protection. Once these are filtered out, on-site investigation by members of the staff could identify the critical nature of each documented problem. Some limited volunteer work has already been done. This program should become more formalized.

Another means of conducting continuous monitoring of shoreline conditions is by the use of aerial photography. This could consist of a continuation of the program of semi-annual flights already initiated by the Office of Shore Protection or by the use of low altitude, oblique aerial photographs taken from a light plane. Another procedure would be establishment of a ground monitoring system. Four wheel drive vehicles could be used in those areas with low groins. In many areas (e.g. the northern part of the state where groins are high and impassable and where a continuous seawall exists) this type of reconnaissance would not be practical. Such areas could be walked. Considering the magnitude of the problem in such areas, the expenditures in manpower are justified. Ongoing reconnaissance should pay particular attention to the areas of particular concern and these areas should be periodically visited on the ground.

Mechanisms should be established to insure fast action is applied to take care of any problem identified in the surveillance program before it gets worse.

### Protection Measures

#### Monitoring

Beach protection structures should be monitored to insure that they are functioning properly, and provision should be made for altering beach protection measures if they do not function as originally intended. The Corps of Engineers, Coastal Engineering Research Center has developed guidelines for determining changes in location of the shore, and for analyzing the effectiveness of various types of structures which may be installed. A minimum program for recording shoreline changes is to measure the distance from a building to the water's edge and the length of the property lines in early spring, mid-summer, and late fall. These lengths



should be measured in a horizontal plane and extend out to the shoreline or to a convenient wading depth. The location of the top of a bluff or dune should be noted in all cases (CERC, 1975).

This minimum program is identified here as just one procedure which may be employed by the state. The CERC report identifies optimum programs for recording shoreline changes and criteria for upgrading or downgrading the minimum program on the basis of surveys. It also identifies the conditions under which beach protection structures should be monitored and it outlines methodologies which can be developed and used to treat individual problem areas by selecting procedures which lie between the minimum and the optimum (CERC, 1975).

### Local Efforts

Considering the high cost of beach protection, it is necessary that the communities contribute as much as they can. However, privately built protection structures are frequently rendered ineffective because of inadequate design and poor construction. The state must insure that the methodologies adopted by local communities and private citizens are well considered and are in the interests of the state as well as the private property owners. This suggests that the state adopt an advisory service to distribute literature or respond to calls or set up extension specialists to make onsite visits. A system of information exchange should be geared to function in both directions so that information on erosional problems could also be obtained from communities and interested citizens.

In 1974, Congress appropriated \$8 million for the Shoreline Erosion Demonstration Act and established a five year program of low cost projects on sheltered waters to demonstrate engineering and vegetation measures. The state should insure that this information gets to the individual private property owners on Delaware and Raritan Bays. In addition to these real-life demonstration projects, pamphlets covering potential beach protection methods (where they are appropriate) should be distributed to local residents.

The communities in the beach fee system have the opportunity for improving the recreational and protective characteristics of the beach. According to N.J. BASC (1977) beach fees and related municipal revenues (parking lot and meter receipts) in some municipalities more than adequately covered municipal expenses for beach management. The resulting surplus is a major source of revenues in these municipalities and it is used to hold down municipal property taxes. Any surplus revenues generated by beach fees could be placed in a special reserve beach fund and used to help defray the costs of State or Federal beach fill projects.

### Sediment Recycling

Long term continuing or periodic sediment recycling schemes should be examined for their practicality and suitable sites should be identified. This method of shore protection has several advantages over static measures (minimal interference with beach dynamics, little ecological destruction, production of usable recreation beach, as well as a protective beach). Considering the high cost of such an operation and the impermanence of the fill materials in the problem area, it is likely that this alternative will not be favorably received by everyone. It is, therefore, important that planners begin a public information program on the opportunities afforded by sediment recycling schemes to speed their implementation.

### Preventive Measures

The state should disseminate information on good building practices to include such items as the importance of not building in the dune district. If such construction is allowed here, houses should be built on pilings where they will not interfere with dune dynamics. The problems associated with bulldozing dunes to provide easy home construction or to provide views of the sea should be stressed. Such a program should call attention to the fact that other shorefront residents are affected by these bad building practices and that the resident has an obligation beyond the protection of his own property.

Many instances show a poor perception of natural hazards by local shorefront residents. A coastal zone management program should provide continual reminders of the necessity to plan for storms and the methods which can be taken to mitigate their effects. The establishment of a hazard warning system could be the responsibility of the advisory service. Information should also be presented on the probabilities of occurrence and what these probabilities mean. The use of such terms as a "100 year storm" often gives residents a false feeling of security.

### Actions Following Hazards

The state should develop contingency plans specifying the steps to be taken following major storms to include the identification of those areas which should be repaired and restored to insure that there is no permanent detrimental long-term effect. Immediate measures include closing new inlets, construction of beaches and dunes to protect newly exposed areas, the use of fill materials and bulkheading to shore up damaged structures, and the clearance or relocation of threatened structures. Long-term effects include the acquisition of land, the relocation of structures not immediately threatened, and the confiscation of shorefront land destroyed by the storms with the subsequent establishment of a dune district (as described in Cape May County, 1976).

## Conclusions

The above paragraphs represent the potential range of activities which may be employed to treat erosion problems on an ongoing basis. It may not be possible to implement all of these measures and implementation of even a very few suggestions would necessitate a considerably expanded Office of Shore Protection. The size of that operation and the powers it will possess will very likely depend upon which of the levels of state control identified on page 3 will be exercised.

### PROCEDURES FOR IDENTIFYING CANDIDATES FOR RESTORATION

This section identifies procedures whereby specific areas may be designated for preservation or restoration for their recreational, ecological, economic, aesthetic, or protective value. The considerable costs of restoration and the inevitable difficulties which may be expected from conflicting interest groups require that the criteria used to identify candidates be carefully considered and reflect the issues of overriding importance. Considering funding restrictions, these areas may have to be limited to the areas of particular concern.

The area need not be solely designated as an erosion area of particular concern. It may be any of the other areas of concern not treated in this report. Restoration should, however, be confined to those locations where the restoration of the beach-dune system is actually required for the preservation of the area of concern and not simply to supplement qualities which already exist there.

The procedure for identifying candidates for restoration should include:

1. the designation of all areas of particular concern (to include ecologically sensitive areas, recreation areas, etc.)
2. a ranking of such areas to reflect their value to the state
3. the identification of those areas where there is an imminent use change resulting from beach erosion
4. the identification of the appropriate method for preservation or restoration based upon the type of resource to be preserved
5. an examination of the potential for preservation of the area through another state or local program
6. implementation of preservation methods through the Office of Coastal Zone Management

Considering the large number of locations in New Jersey where beach erosion is critical, it is likely that there will be many candidates for restoration efforts. Therefore, a ranking procedure must be developed. In its simplest form, such a procedure could consist of identifying all of the selection criteria used to identify areas of concern and then identifying the specific sites which possessed the greatest number of these entries (see Table 7 for a generalized list of such criteria). The selection criteria could also be ranked and assigned values based on their theoretical importance to the economy/ecology of the state, and areas with highest rank could be given the first consideration.

Table 7. Generalized selection criteria for identifying candidates for restoration (modified from the New Hampshire OCZM program)

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1. Areas of unique, scarce, fragile, or vulnerable natural habitat or physical feature.
  2. Areas of historical or cultural importance.
  3. Areas of high natural productivity or of essential habitat.
  4. Areas of scenic importance.
  5. Areas of substantial recreational value.
  6. Areas where development and facilities are dependent upon the utilization of, or access to, the beach and/or dune environments.
  7. Areas of unique geologic or topographic significance to agricultural, industrial, or commercial development.
  8. Areas of urban concentration.
  9. Developed areas of significant hazard.
  10. Areas needed to protect, maintain, or replenish coastal lands or resources.
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The items contained in Table 7 are only presented in generalized form and they are not ranked in terms of value. A more complete itemized list of specific attributes along with numerical values representing their perceived importance to the State must be developed and used to weigh areas of concern.

It is recognized that candidates for restoration efforts may also be selected which do not provide a unique opportunity for shoreline land use in their present state but which, through

augmentation, would provide such a resource. An example of this would be the development of a particular portion of the shoreline into a local or state park which would involve cosmetic changes. The improvement of such areas is not an objective of the CZM program, however.

A further criterion for selection is that there must be an urgent need for preservation or restoration. This implies that there is an imminent use change in the area. In terms of the present report, this means the direct removal of the resources through beach erosion. If restoration of the natural protection of the beach and dune is required as the principle or sole means of preserving the resource, then such restoration is appropriate. If, however, the imminent use change is not related to beach dynamics, then this alternative is not appropriate even though such restoration may improve conditions in the problem area. In many cases, the imminent use change would be the direct destruction of the resources behind the beach due to loss of beach protection. In other cases, the resource may be the beach itself (or the dunes) which provides protective habitat or scenic or recreational value. Both of these situations require protection or restoration. However, the methods may differ; areas of scenic or recreational value require protective measures compatible with the natural setting (i.e. the use of beach fill and dune fill with dune grass planting or simply cosmetic changes) whereas the protection of inland resources could be accomplished using static beach protection devices such as groins, bulkheads, and seawalls.

A final requirement for areas to receive restoration efforts is that the situation cannot be taken care of through another state or local program. This requires a thorough search of all other programs available within the state to preserve such high quality resource areas. The capabilities of these programs must be determined and efforts must be coordinated to insure that each area of concern receives proper consideration and that there is no duplication of effort.

## CONCLUDING STATEMENT

The high degree of beach mobility, high rates of erosion, and the ever-present hazard of building in the beach and dune environment call attention to the need for careful land use planning for the New Jersey shoreline. The magnitude of the problem is great, and solutions may be costly. Further, many of the suggested improvements to beach management problems will affect other portions of the shoreline than the immediate problem area. This implies that supervision by higher levels of government is required. It, therefore, appears that a greater degree of State involvement is necessary.

The management guidelines suggested here are believed to provide a general overall framework within which specific policies may be developed. However, this operational framework, and the policies which are developed, should be flexible so that they may change as the 'state of the art' in beach protection improves and as the importance of the beaches to recreation and to the general economy of the shorefront areas changes through time.

## REFERENCES CITED

- Cape May County N.J. Planning Board. Cape May County Comprehensive Plan. Cape May Court House, N.J., 1976.
- Dolan, R. "Barrier islands: natural and controlled". Coastal Geomorphology, in Coates, D., ed. Binghamton, New York: State University of New York, 1973.
- Godfrey, P. and Godfrey, M. "Comparison of ecological and geomorphic interactions between altered and unaltered barrier island systems in North Carolina". Coastal Geomorphology, in Coates, D., ed. Binghamton, New York: State University of New York, 1973.
- Mitchell, James K. Community Response to Coastal Erosion. Research Paper No. 156. Chicago: University of Chicago, Department of Geography, 1974.
- New Jersey Beach Access Study Commission. Public access to the oceanfront beaches: a report to the Governor and Legislature of New Jersey. Trenton, N.J., State House, 1977.
- New Jersey Office of Coastal Zone Management. Alternatives for the Coast. Trenton, 1976.
- Natural Resources Defense Council, Inc. Who's minding the shore? A citizen's guide to coastal management. Washington, D.C., Office of Coastal Zone Management, 1976.
- U.S. Coastal Engineering Research Center. Guidelines for Monitoring Shore Protection Structures in the Great Lakes. Miscellaneous Paper No. 2-75. Washington, D.C., 1975.
- U.S. National Oceanic and Atmospheric Administration. State Coastal Zone Management Activities 1975-1976. Washington, D.C., 1976.